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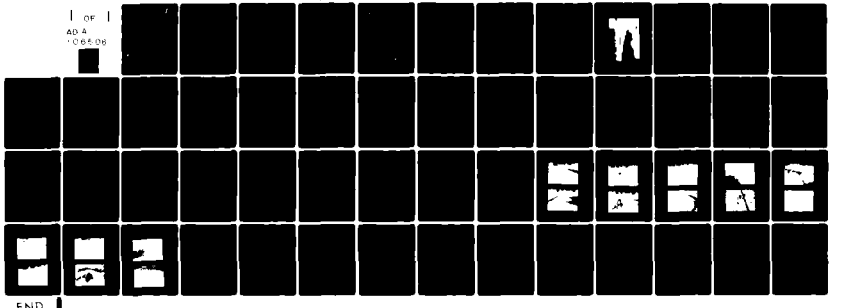

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ODESSA HILLS LAKE DAM

LAFAYETTE COUNTY, MISSOURI

MO 10534

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT. ST. LOUIS

FOR: STATE OF MISSOURI

8

MAY 1980

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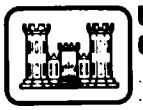
MISSOURI-KANSAS CITY BASIN

ODESSA HILLS LAKE DAM

LAFAYETTE COUNTY, MISSOURI

MO 10534

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



United States Army
Corps of Engineers
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St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT. ST. LOUIS

FOR: STATE OF MISSOURI

MAY 1980

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

LMSED-PD

SUBJECT: Odessa Hills Lake Dam, MO. I.D. No. 10534
Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Odessa Hills Lake Dam.

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SIGNED

SUBMITTED BY: _____ 8 SEP 1980
Chief, Engineering Division Date

SIGNED

APPROVED BY: _____ 8 SEP 1980
Colonel, CE, District Engineer Date

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ODESSA HILLS LAKE DAM

LAFAYETTE COUNTY, MISSOURI

MISSOURI INVENTORY NO. 10534

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

UNDER DIRECTION OF

ST. LOUIS DISTRICT CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

MAY 1980

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Odessa Hills Lake Dam
State Located	Missouri
County Located	Lafayette County
Stream	Tributary to the East Fork of Sni-A-Bar Creek
Date of Inspection	13 May 1980

Odessa Hills Lake Dam was inspected by a team of engineers from Black & Veatch, Consulting Engineers for the St. Louis District, Corps of Engineers. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and state agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. According to the St. Louis District, Corps of Engineers, failure would threaten lives and property. The estimated damage zone extends approximately two miles downstream of the dam. Within the estimated damage zone are six to ten cabins used by a church camp and one barn. Contents of the estimated downstream damage zone were verified by the inspection team.

Our inspection and evaluation indicates the spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillways will not pass the probable maximum flood without overtopping the dam but will pass 10 percent of the probable maximum flood. The spillways will not pass the one percent probability flood (100-year flood). The spillway design flood recommended by the guidelines is 50 to 100 percent of the probable maximum flood. Considering the downstream hazard, the spillway design flood should be 100 percent of the probable maximum flood. The probable maximum flood is defined as the flood discharge which may be expected from the most severe combination of critical meteorologic and hydrologic conditions which are reasonably possible in the region. The one percent probability flood is defined as the flood which has a one percent probability of occurring in any one year period.

Based on visual observations, this dam appears to be in good condition. The only deficiency visually observed by the inspection team was erosion in the following areas: on the upstream slope a vertical face has developed; on the right abutment at the downstream end of the concrete-lined ditch; on the downstream slope of the embankment above and to the left side of the primary spillway outlet pipe; and in the bottom of the emergency spillway channel which is located on the left abutment. Seepage and stability analyses required by the guidelines were not available.

There were no observed deficiencies or conditions existing at the time of the inspection which indicated an immediate safety hazard. Future corrective action will be required to correct or control the described deficiency. In addition, detailed seepage and stability analyses of the existing dam, as required by the guidelines, should be performed. A detailed report discussing each of these deficiencies is attached.

Paul R. Zaman

Paul R. Zaman, PE
Illinois 62-29261

Edwin R. Burton

Edwin R. Burton, PE
Missouri E-10137

Harry L. Callahan

Harry L. Callahan, Partner
Black & Veatch

OVERVIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
ODESSA HILLS LAKE DAM

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APPENDIX

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the District Engineer of the St. Louis District, Corps of Engineers, directed that a safety inspection of the Odessa Hills Lake Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth structure located in the valley of a tributary to the East Fork of Sni-A-Bar Creek on the grounds of a church camp (see Plate 1). The watershed is an area of low hills consisting of 50 percent cropland and 50 percent grassland (see Plate 2). The dam is approximately 330 feet long along the crest and 23 feet high. The dam crest is 11 feet wide. The downstream face of the dam has a fairly uniform slope from the crest to the valley floor below.

(2) The primary spillway is an uncontrolled 48-inch diameter concrete morning-glory type drop inlet with a trash screen and a 36-inch diameter corrugated metal pipe through the dam. Flow through the pipe discharges into a plunge pool and then into the natural stream channel below the dam. Soundings were made and it was determined that the bottom of the plunge pool was covered with broken rock. The grass-lined emergency spillway channel is located at the left abutment. A foot bridge traverses the emergency spillway channel. A training berm separates the emergency spillway from the embankment. A concrete sill has been poured near an overfall at the downstream end of the emergency spillway.

(3) A 12-inch diameter drainage pipe from the access road discharges to the emergency spillway discharge channel downstream of the emergency spillway crest.

(4) Pertinent physical data are given in paragraph 1.3.

b. Location. The dam is located in Lafayette County, Missouri, as indicated on Plate 1. The lake formed by the dam is in an area shown on the United States Geological Survey 7.5 minute series quadrangle map for Odessa North, Missouri in Section 15 of T49N, R28W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, the dam and impoundment are in the small size category.

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Odessa Hills Lake Dam has a high hazard potential, meaning that the dam is located where failure may cause loss of life, and serious damage to homes, agricultural, industrial and commercial facilities, and to important public utilities, main highways, or railroads. For the Odessa Hills Lake Dam the estimated flood damage zone extends approximately two miles downstream of the dam. Within the estimated damage zone are six to ten cabins used by the camp and one barn. Contents of the estimated downstream damage zone were verified by the inspection.

e. Ownership. The dam is owned by the Reorganized Church of Jesus Christ of the Latter Day Saints, P. O. Box 350, Warrensburg, Missouri, 64093, Telephone 816-747-6193.

f. Purpose of Dam. The dam forms a 7-acre lake used for recreation and flood control.

g. Design and Construction History. No design information was available. The dam was constructed in 1954 by Raymond Aufenkemp of Higginsville, Missouri.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, evaporation, and overflow through the uncontrolled drop inlet all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 756 acres

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through an uncontrolled 48-inch drop inlet and a 36-inch outlet pipe through the embankment.

(2) Estimated experienced maximum flood at damsite - Unknown.

(3) Estimated ungated spillway capacity at maximum pool elevation 2,100 cfs (Probable Maximum Flood Pool El. 773.7).

c. Elevation (Feet above m.s.l.).

(1) Top of dam - 769.4 (see Plate 3)

(2) Emergency spillway crest - 766.0

(3) Primary spillway drop inlet crest - 765.0

(4) Streambed at toe of dam - 747.0 ±

(5) Maximum tailwater - Unknown.

d. Reservoir.

(1) Length of maximum pool - 2,200 feet ± (Probable maximum flood pool level)

(2) Length of normal pool - 600 feet ± (Primary spillway drop inlet crest)

e. Storage (Acre-feet).

(1) Top of dam - 81

(2) Emergency spillway crest - 55.5

(3) Primary spillway drop inlet crest - 48

(4) Design surcharge - Not available.

f. Reservoir Surface (Acres).

(1) Top of dam - 11.6

(2) Emergency spillway crest - 6.1

(3) Primary spillway drop inlet crest - 4.5

g. Dam.

(1) Type - Earth embankment

(2) Length - 331 feet

(3) Height - 23 feet ±

(4) Top width - 11 feet

(5) Side slopes - upstream face 1.0 V on 3.0 H, downstream face between 1.0 V on 2.7 H and 1.0 V on 3.0 H (see Plate 4)

(6) Zoning - Unknown.

(7) Impervious core - Unknown.

(8) Cutoff - Unknown.

(9) Grout curtain - None.

h. Diversion and Regulating Tunnel - None.

i. Primary Spillway.

(1) Type - 4-foot diameter drop inlet to a 3-foot diameter corrugated metal pipe.

(2) Inlet crest elevation - 765.0 feet m.s.l.

(3) Inlet invert elevation 3-ft. dia. CMP - 759.9 feet m.s.l.

(4) Outlet invert elevation 3-ft. dia. CMP - 745.5 feet m.s.l.

(5) Gates - None.

(6) Upstream channel - Not applicable.

(7) Downstream channel - Natural channel to streambed.

j. Emergency Spillway.

(1) Type - Grass open channel.

(2) Width of channel - 45 ± feet.

(3) Emergency spillway crest - 766.0.

(4) Gates - None.

(5) Upstream channel - Not applicable.

(6) Downstream channel - Natural open channel to a streambed.

k. Regulating Outlets - None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data were unavailable. The Missouri Department of Natural Resources inventoried the dam on 14 November 1979.

2.2 CONSTRUCTION

Construction records were unavailable, however, according to the campground manager, the dam was constructed in 1954.

2.3 OPERATION

Documentation of past floods was not available.

2.4 GEOLOGY

The site of Odessa Hills dam and reservoir is located in a deeply dissected valley between two ridges. The dam impounds a small, intermittent, side tributary of the East Fork of Sni-A-Bar Creek.

The soils of the dam and reservoir area consist of the Sogn, Winfield and Blackoar soil series. The Sogn series consists of shallow, somewhat excessively drained, loamy soils on uplands formed under grasses and deciduous trees in residuum that varies from 4 to 20 inches. Beneath the residuum is limestone or interbedded limestone, shale, or sandstone. The soil is classified for engineering purposes as a low plastic clay (CL). The Winfield series consists of deep, moderately well-drained, loamy soils on ridgetops and hillsides on uplands. These soils formed under deciduous hardwoods in 3 or more feet of loess. The loess is underlain by limestone, shale, or sandstone bedrock. For engineering purposes, the soils are classified as low plastic silt (ML) and low plastic clay (CL). The Blackoar series consists of deep, poorly drained, nearly level, loamy soils on bottom lands that are along small streams. These soils formed under tall grasses in 3 or more feet of alluvium. Beneath the alluvium is limestone, shale, or sandstone bedrock. For engineering purposes, the soil is classified as a low plastic silt (ML) or low plastic clay (CL).

The bedrock of the dam and reservoir area consists of limestone, shale, coal and sandstone of the Marmaton Group, Des Moinesian series, Pennsylvanian System.

2.5 EVALUATION

a. Availability. No engineering data could be obtained.

b. Adequacy. No engineering data were available upon which to make a detailed assessment of the design, construction, and operation. Detailed seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. The validity of the design, construction, and operation could not be determined due to the lack of engineering data.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Odessa Hills Lake Dam was made on 13 May 1980. Specific observations are discussed below. No observations were made of the condition of the upstream face of the dam below the pool elevation at the time of the inspection.

b. Dam. The inspection team observed the following conditions at the dam. No cracks, sloughing or other signs of settlement were observed. The embankment has no visible stability problems. No instruments to measure the performance of the dam were located.

No evidence of seepage was observed in the embankment or the abutments. No toe drains or relief wells were observed.

The dam crest has a gravel roadway and the upstream and downstream faces have a grass slope protection. Erosion of silty clay (CL) material was observed in the following areas: on the upstream slope a vertical face has developed due to wave action; on the right abutment to a depth of about one foot at the downstream end of the concrete-lined ditch; a minor amount on the downstream slope above and on the left side of the principal spillway outlet pipe due to slope runoff; and in the bottom of the emergency spillway channel, located on the left abutment, which was caused by surface runoff and flow from the 12-inch drainage pipe which discharges into the left side of the emergency spillway channel. This erosion is unlikely to become a problem in the foreseeable future. No evidence was found to indicate the embankment had ever been overtopped.

Evidence that a maintenance program was in effect included mowing of grass on the embankment, no trees growing on the embankment and the absence of animal burrows (the animal control program includes trapping of muskrats in winter). The general condition of the embankment was considered good. The grass slope protection is adequate to withstand erosion except at the 12-inch drainage pipe outflow on the left abutment.

The channel upstream of the lake contains much debris and many trees. The lake contains major amounts of siltation.

c. Appurtenant Structures. The inspection team observed the following items pertaining to the appurtenant structures. The primary spillway is an uncontrolled 48-inch diameter concrete morning-glory type drop inlet and a 36-inch diameter corrugated metal pipe through the embankment. The total length of the 36-inch CMP was inspected from the downstream end and was found to have about a 3-inch sag in the crown of the pipe located about one-third the length from the downstream end.

The horizontal alinement was straight. About 15 feet of the top of the CMP exterior at the downstream end was inspected and no corrosion was found. The pipe joints themselves could not be observed and the majority of the spillway pipe was considered unobservable. No evidence of leakage was noted into, out of, or around the spillway pipe. The minor amount of erosion of embankment material observed at the left side of the outlet pipe may not become a problem. Soundings were made at the pipe outlet to determine that the bottom of the plunge pool was protected by riprap. The principal spillway is considered to be in satisfactory condition.

The emergency spillway is a grass-lined channel located on the left abutment. Some erosion of the channel bottom was observed due to surface runoff and flow from the 12-inch drainage pipe which discharges into the left side of the spillway channel. Also at the downstream overfall section of the spillway, the concrete sill was observed to be undercut, the concrete lining damaged, and the channel bottom eroded. This erosion is unlikely to become a problem in the foreseeable future.

The emergency spillway contains no obstructions to flow. The grass-lined bottom and side slopes are mowed and in good condition and the protection is considered to be adequate for short duration flows. It is possible that an abnormally large spillway discharge would overflow the training berm that separates the channel from the embankment and erode the embankment.

There are several cabins downstream in the emergency spillway area. The sleeping cabins are located at an elevation higher than the training berm. Other cabins are used only during the daytime for camp crafts.

d. Geology. The soil on the slopes above the reservoir are formed in loess and classified as the Winfield soil series by the USDA/SCS. The soil downstream of the embankment is formed in alluvium and is classified as the Blackoar soil series by the USDA/SCS. The soils on the left side of the reservoir looking downstream are classiied as the Sogn soil series by the USDA/SCS. The depth to rock beneath these soils is anticipated to be 2 to 10 feet.

Samples of the soil in the spillway and the embankment were taken using an Oakfield sampler. The near-surface material cosisted of a silty, low plastic clay. The samples were visually classified in accordance with ASTM D 2488-61. Based on these samples, it is anticipated that the embankment consists of silty clay of low plasticity.

One small outcrop of sandstone was observed in a drainage ditch above the left abutment. This outcrop displayed two sets of widely spaced, vertical joints approximately 2 to 3 inches wide. The bedding was horizontal and medium bedded. No other outcrops were observed in

the area of the dam. Based on observations and published data, it is anticipated that the abutments and foundation of the dam consist of interbedded limestone, shale, and sandstone of the Marmaton Group, overlain by Winfield, Sogn or Blackoar soils.

According to the caretaker, the reservoir is fed by springs. However, no springs or discharges from the surrounding area were observed.

e. Reservoir Area. No slumping or slides were observed in the reservoir area.

f. Downstream Channel. The channel below the primary spillway is the natural open channel of the original streambed. It contains no obstructions to flow. The emergency spillway channel overfalls to a natural open channel to the original streambed.

3.2 EVALUATION

The various deficiencies observed at the time of the inspection are not believed to represent an immediate safety hazard. They do, however, warrant monitoring and control. Due to the absence of riprap on the upstream face of the dam, a vertical face has developed at the waterline. If not corrected, wave action will continue to erode the embankment and could lead to stability problems. The erosion on the downstream slope above the outlet pipe and at the left side of the oulet pipe will continue unless suitable backfill material and slope protection is provided. On the right abutment, erosion of material was evident at the downstream end of the concrete-lined ditch. Surface runoff and flow from the 12-inch drainage pipe which discharges into the left side of the channel has caused erosion of the emergency spillway channel bottom. The lack of invert protection i.e., rock, concrete or other suitable lining will result in continued erosion of the silty clay material.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool is primarily controlled by rainfall, runoff, evaporation, transpiration, and capacity of the uncontrolled primary spillway outlet pipe.

4.2 MAINTENANCE OF DAM

The existing maintenance program includes mowing of grass on the slopes of the dam. Also winter trapping of muskrats is a continuing program.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no existing warning system or preplanned scheme for alerting downstream residents for this dam. Use of cabins immediately below the dam is restricted to daytime occupancy for supervised camp programs.

4.5 EVALUATION

The present program of mowing and trapping has developed a good grass cover for the slope protection and kept the embankment free of trees and burrowing animals. Additional maintenance is needed to correct and control areas of erosion.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data pertaining to hydrology and hydraulics were unavailable.

b. Experience Data. The drainage area and lake surface area are developed from USGS Odessa North Quadrangle Map. The dam layout is from a survey made during the inspection.

c. Visual Observations.

(1) The primary spillway appears to be in good condition. The lake level at the time of the inspection was at the inlet level (El. 765.0) and there was flow through the pipe. The total length of the corrugated metal pipe could be observed from the downstream end. The morning-glory type drop inlet could be observed from the upstream end. The spillway pipe discharges with a free outfall into a natural channel. There were no obstructions to flow in the downstream channel.

(2) The emergency spillway channel is in good condition but had some erosion of the channel bottom at the time of the inspection.

(3) Short duration spillway discharges do not endanger the integrity of the dam.

d. Overtopping Potential. The spillways will not pass the probable maximum flood without overtopping the dam. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The spillways will pass 10 percent of the probable maximum flood without overtopping the dam. The spillways fail to pass the one percent probability flood which is estimated to have a peak outflow of 1,400 cfs developed by a 24-hour, one percent probability rainfall. According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of small size should pass 50 to 100 percent of the probable maximum flood. Considering the downstream hazard, the appropriate spillway design flood should be 100 percent of the probable maximum flood. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 5,100 cfs of the total discharge from the reservoir of 7,200 cfs. The estimated duration of overtopping is 6.7 hours with a maximum height of 4.3 feet. Overtopping for this period of time could jeopardize the embankment. The portion of the estimated peak discharge of 50 percent of the probable maximum flood overtopping the dam would be 2,100 cfs of the total discharge from the reservoir of 3,600 cfs. The estimated duration of overtopping is 5.5 hours with a maximum height of 2.70 feet.

According to the St. Louis District of the Corps of Engineers, the effect from rupture of the dam could extend approximately two miles downstream of the dam. Six to ten cabins and one barn are located in the estimated damage zone. Contents of the estimated downstream damage zone were verified by the inspection team.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which affect the structural stability of this dam are discussed in Section 3, paragraph 3.1b.

b. Design and Construction Data. No design data relating to the structural stability of the dam were found. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Operating Records. No operational records exist.

d. Postconstruction Changes. In 1979 a new grille was added to the primary spillway drop inlet.

e. Seismic Stability. The dam is located in Seismic Zone 1 which is a zone of minor seismic risk. A properly designed and constructed earth dam using sound engineering principles and conservatism should pose no serious stability problems during earthquakes in this zone. The seismic stability of an earth dam is dependent upon a number of factors: embankment and foundation material classifications and shear strengths; abutment materials, conditions, and strengths; embankment zoning; and embankment geometry.

Adequate descriptions of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the stability analysis required by the guidelines.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several conditions observed during the visual inspection by the inspection team should be corrected, monitored, and/or controlled. These are the absence of riprap on the upstream slope of the embankment, lack of suitable invert protection at the left abutment 12-inch drainage pipe in the emergency spillway channel, the right abutment concrete-lined ditch and the primary spillway outlet pipe.

b. Adequacy of Information. Due to the lack of engineering design data, the conclusions in this report were based only on performance history and visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. A program should be developed as soon as possible to monitor at regular intervals the deficiencies described in this report. The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. The item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II. The Phase I investigation does not raise any serious questions relating to the safety of the dam nor does it identify any serious dangers which would require a Phase II investigation. However, the additional analyses noted in paragraph 2.5b are necessary for compliance with the guidelines.

e. Seismic Stability. This dam is located in Seismic Zone 1. Adequate description of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment was not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the recommended stability analysis.

7.2 REMEDIAL MEASURES

a. Alternatives. The emergency spillway size and/or height of the dam would need to be increased or the lake level would need to be lowered to increase available flood storage in order to pass the spillway design flood.

b. Operation and Maintenance Procedures. The following operation and maintenance procedures are recommended and should be implemented

under the direction of a professional engineer experienced in the design, construction, and maintenance of earth dams.

(1) Riprap should be placed on the upstream face of the dam to prevent erosion of the embankment material due to wave action.

(2) Suitable invert protection i.e., rock, concrete or other lining should be placed at the outlet of the 12-inch drainage pipe once the eroded material has been replaced and compacted.

(3) Suitable backfill material should be replaced and compacted in the eroded sections of the emergency spillway channel and protective grasses replanted.

(4) Suitable backfill material should be replaced at the left side of the primary spillway outlet pipe.

(5) The concrete-lined ditch on the right abutment should be repaired and extended.

(6) Grass cover on the embankments should continue to be cut periodically.

(7) Seepage and stability analyses should be performed.

(8) A detailed inspection of the dam should be made periodically. More frequent inspections may be required if additional deficiencies are observed or the severity of the reported deficiencies increase.

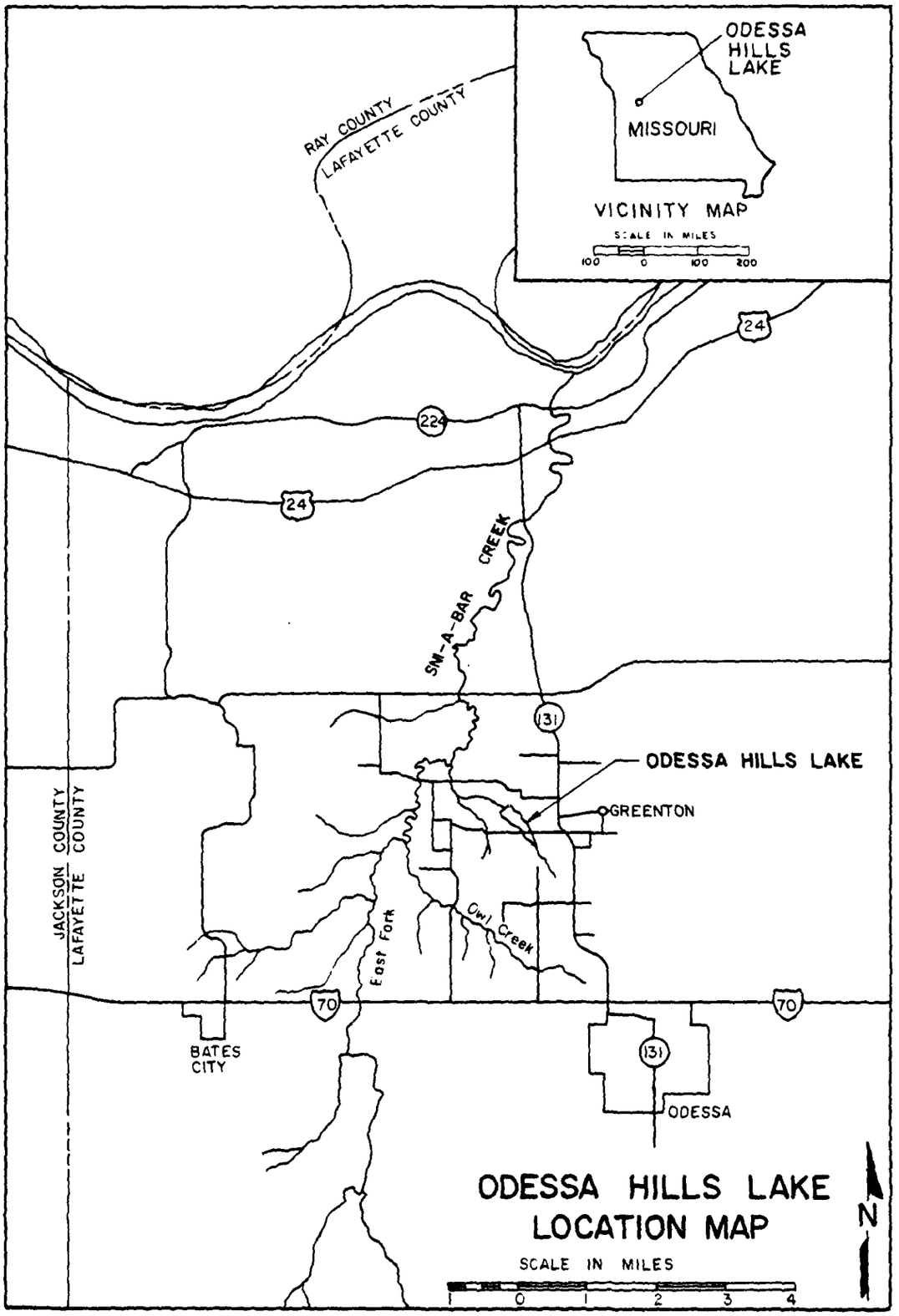
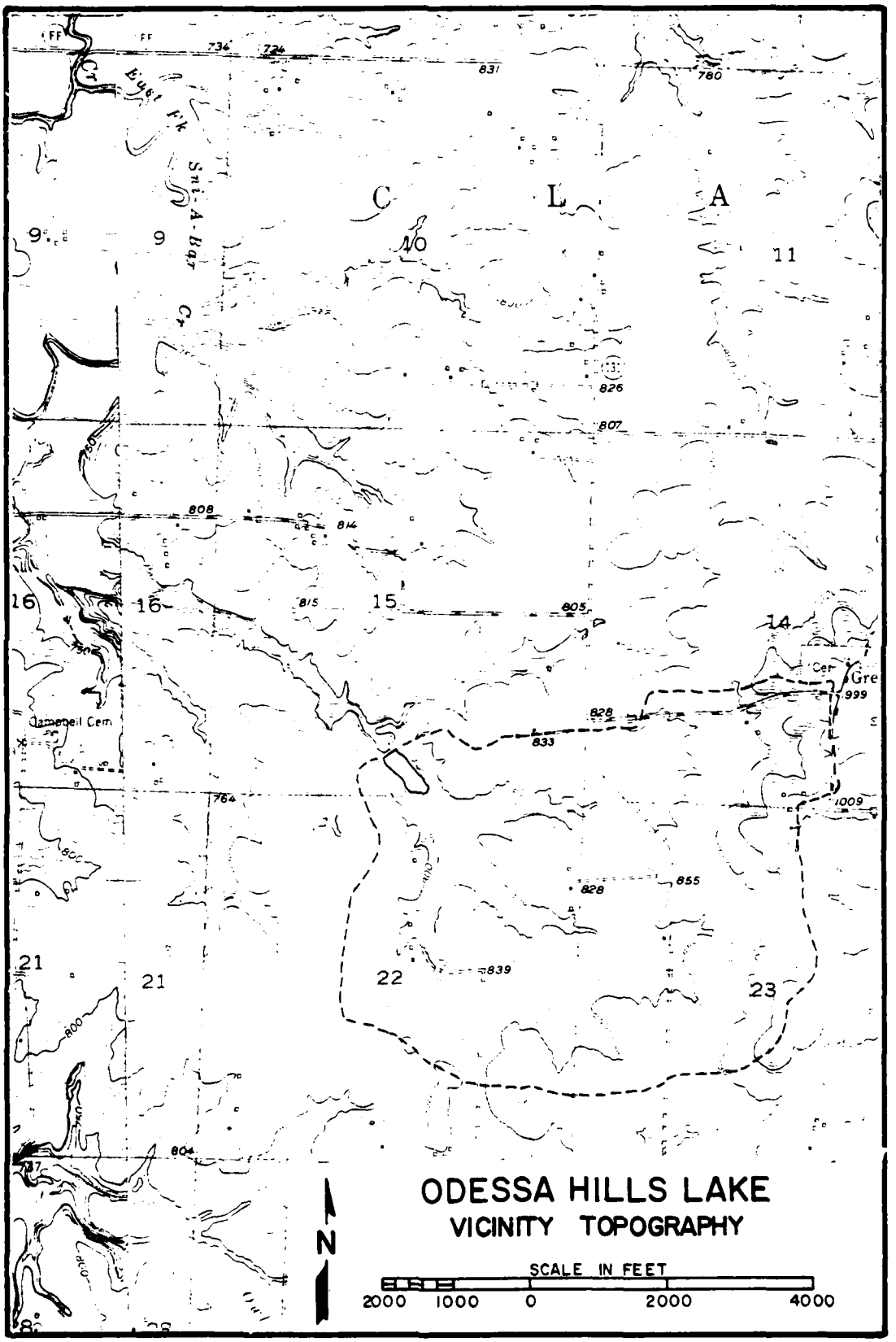

ODESSA HILLS LAKE
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200
RAY COUNTY
LAFAYETTE COUNTY
24
224
24
SM-A-BAR CREEK
131
ODESSA HILLS LAKE
GREENTON
JACKSON COUNTY
LAFAYETTE COUNTY
East Fork
Owl Creek
70
70
BATES CITY
131
ODESSA
ODESSA HILLS LAKE
LOCATION MAP
SCALE IN MILES
0 1 2 3 4
N

PLATE 1



ODESSA HILLS LAKE
VICINITY TOPOGRAPHY

PLATE 2

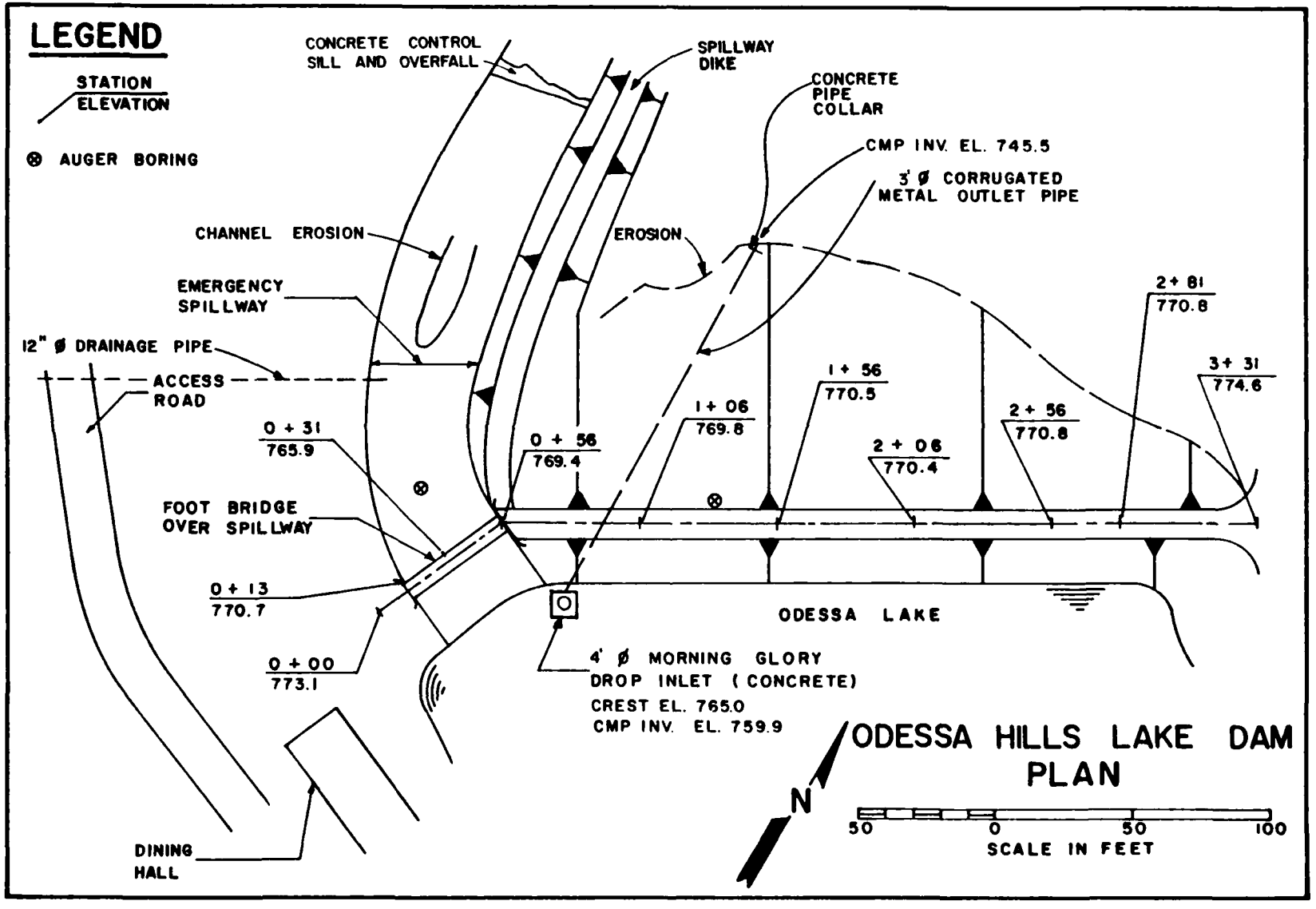

LEGEND
STATION
ELEVATION
AUGER BORING
CONCRETE CONTROL SILL AND OVERFALL
SPILLWAY DIKE
CONCRETE PIPE COLLAR
CMP INV. EL. 745.5
3' Ø CORRUGATED METAL OUTLET PIPE
CHANNEL EROSION
EROSION
EMERGENCY SPILLWAY
12" Ø DRAINAGE PIPE
ACCESS ROAD
0 + 31
765.9
0 + 56
769.4
1 + 06
769.8
1 + 56
770.5
2 + 06
770.4
2 + 56
770.8
2 + 81
770.8
3 + 31
774.6
FOOT BRIDGE OVER SPILLWAY
0 + 13
770.7
0 + 00
773.1
ODESSA LAKE
4' Ø MORNING GLORY DROP INLET (CONCRETE)
CREST EL. 765.0
CMP INV. EL. 759.9
DINING HALL
N
ODESSA HILLS LAKE DAM
PLAN
50
0
50
100
SCALE IN FEET

PLATE 3

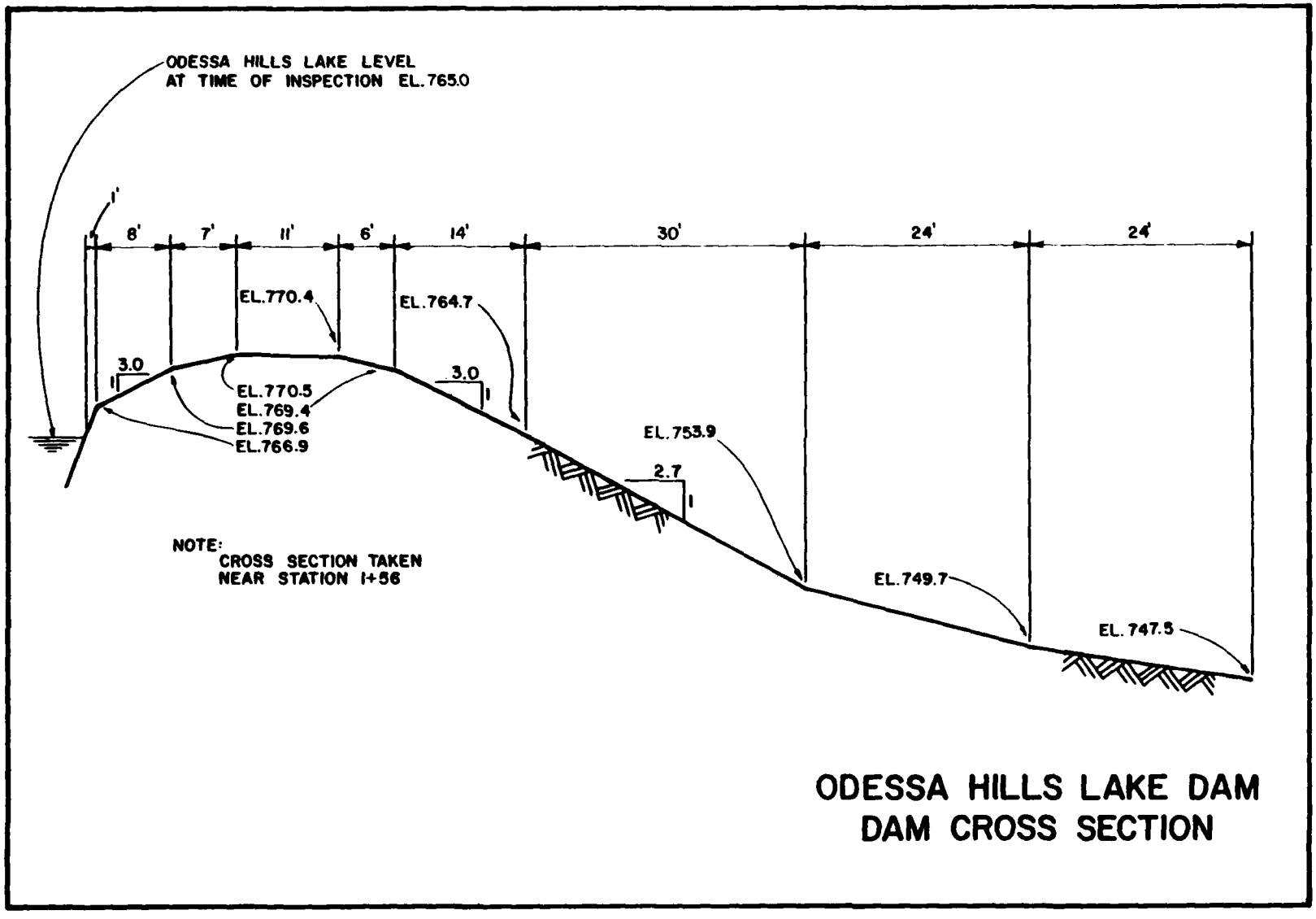
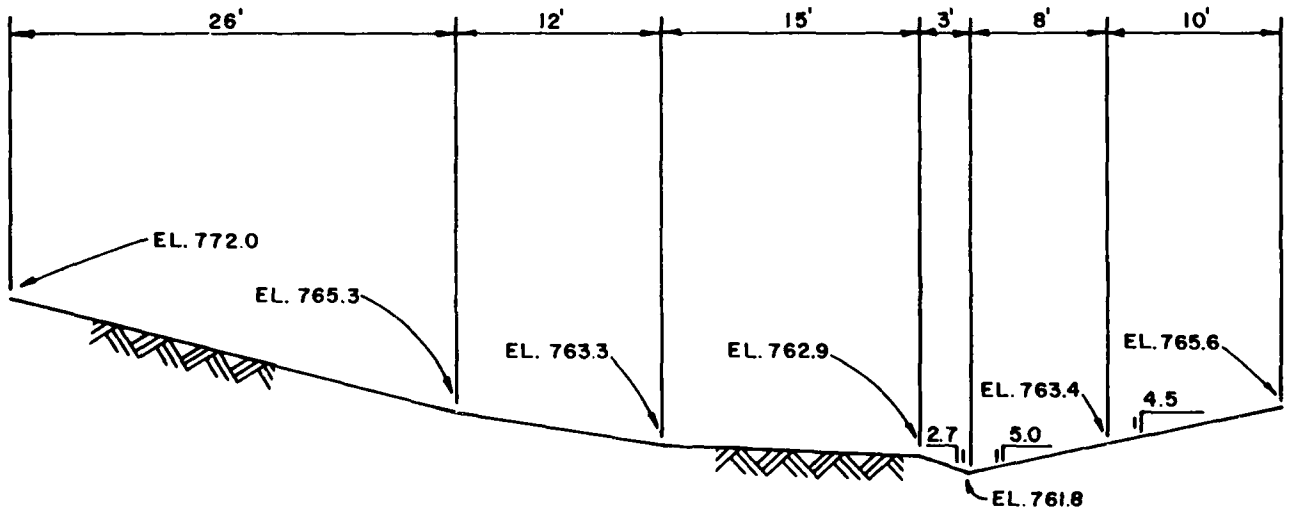


PLATE 4

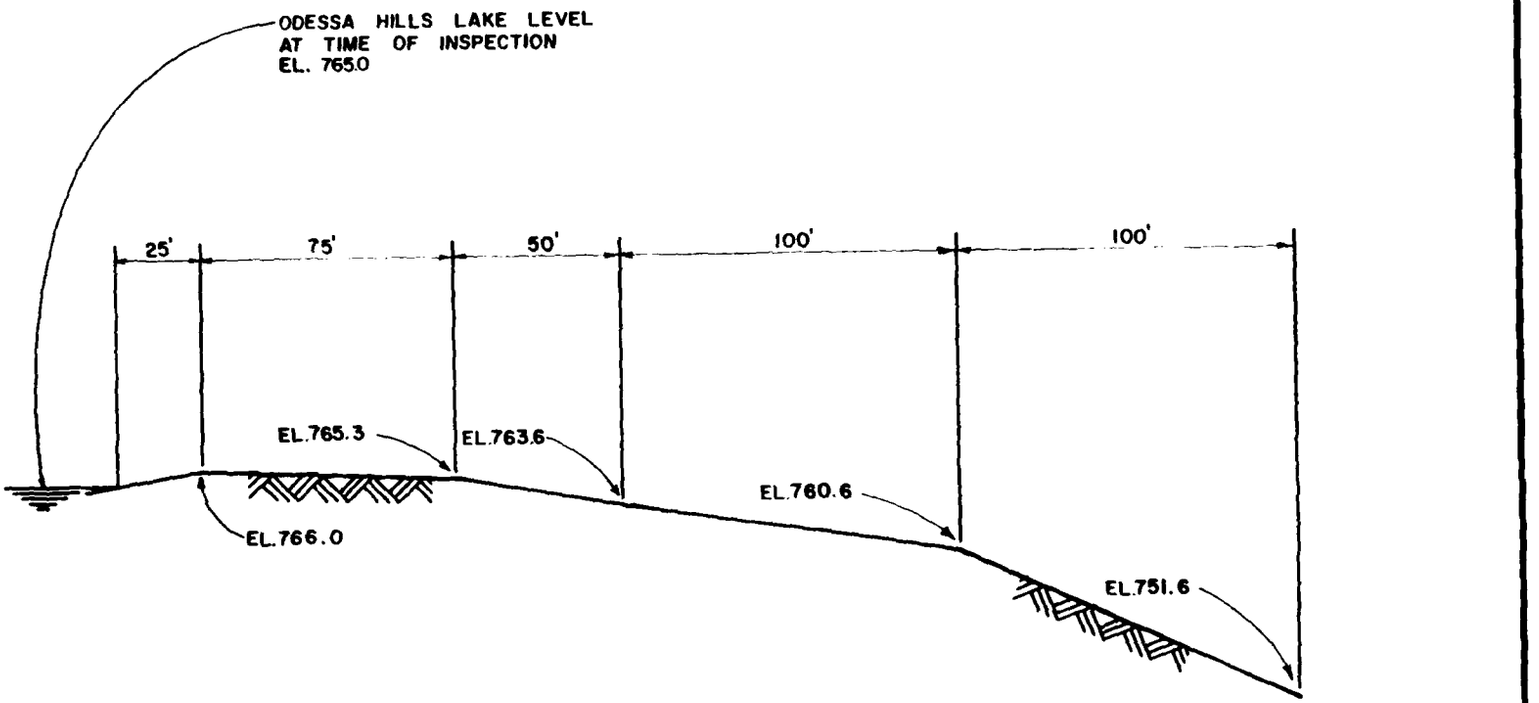
ODESSA HILLS LAKE DAM
DAM CROSS SECTION



NOTE:
CROSS SECTION TAKEN
NEAR STATION 1+50
LOOKING DOWNSTREAM

ODESSA HILLS LAKE DAM
EMERGENCY SPILLWAY CROSS SECTION

PLATE 5



ODESSA HILLS LAKE DAM
EMERGENCY SPILLWAY PROFILE

PLATE 6

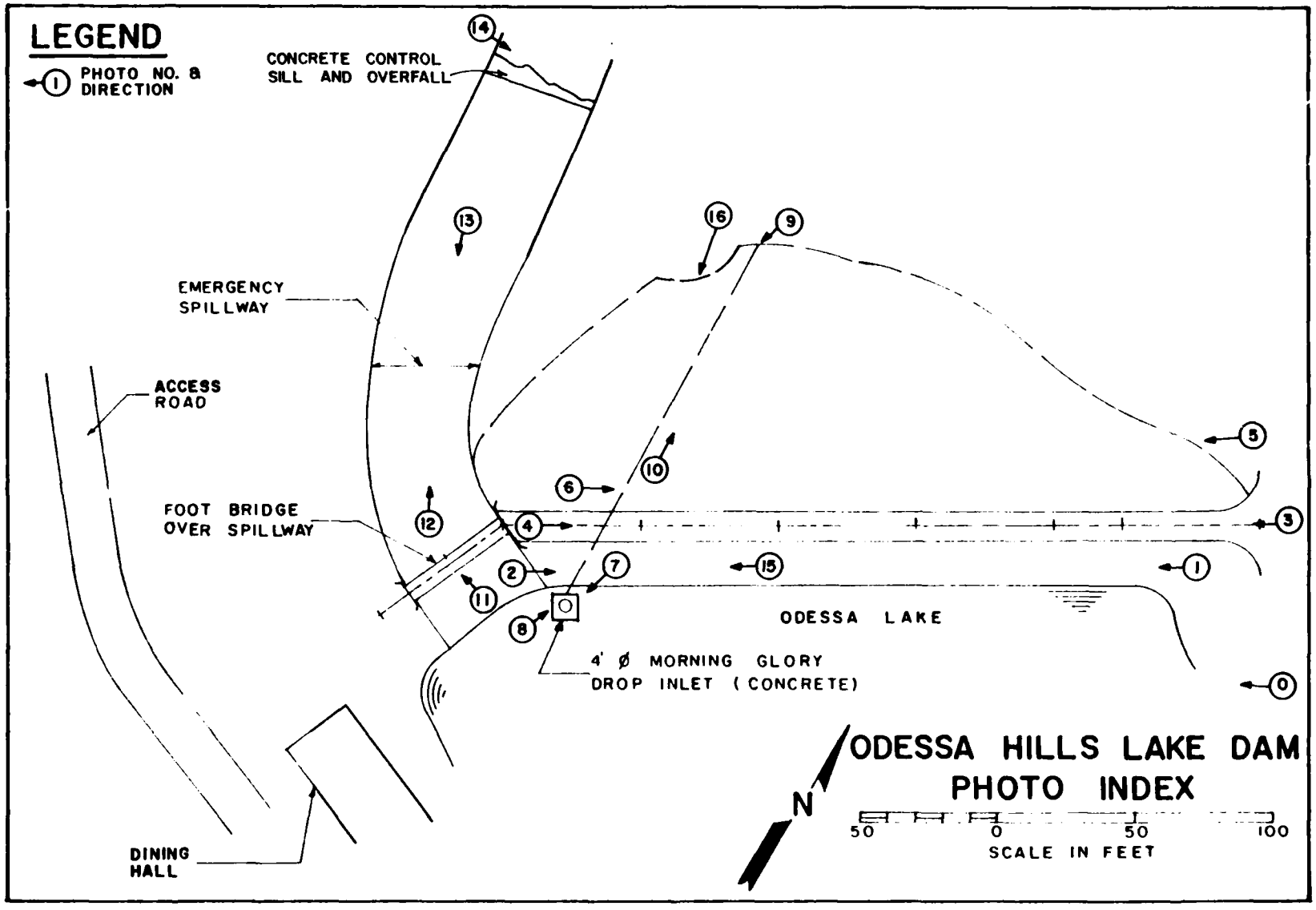

LEGEND
PHOTO NO. & DIRECTION
CONCRETE CONTROL SILL AND OVERFALL
EMERGENCY SPILLWAY
ACCESS ROAD
FOOT BRIDGE OVER SPILLWAY
DINING HALL
ODESSA LAKE
4' Ø MORNING GLORY DROP INLET (CONCRETE)
N
ODESSA HILLS LAKE DAM
PHOTO INDEX
50 0 50 100
SCALE IN FEET

PLATE 7

PHOTO 1: FACE OF DAM LOOKING WEST

PHOTO 2: FACE OF DAM LOOKING EAST

PHOTO 3: CREST OF DAM LOOKING WEST

PHOTO 4: CREST OF DAM LOOKING EAST

PHOTO 5: DOWNSTREAM SLOPE OF DAM LOOKING WEST

PHOTO 6: DOWNSTREAM SLOPE OF DAM LOOKING EAST

PHOTO 7: PRIMARY SPILLWAY DROP INLET AND TRASH SCREEN

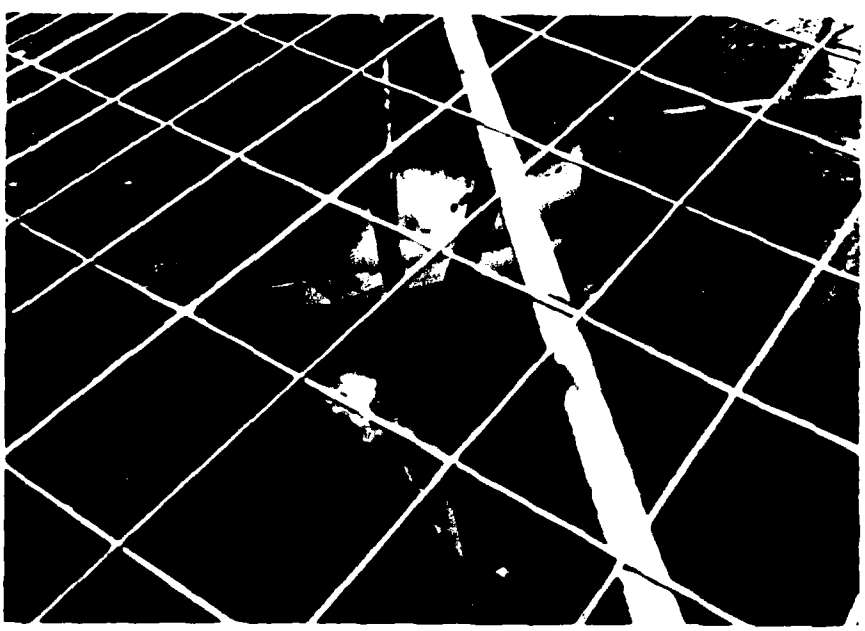


PHOTO 8: PRIMARY SPILLWAY DROP INLET

PHOTO 9: PRIMARY SPILLWAY PIPE OUTLET

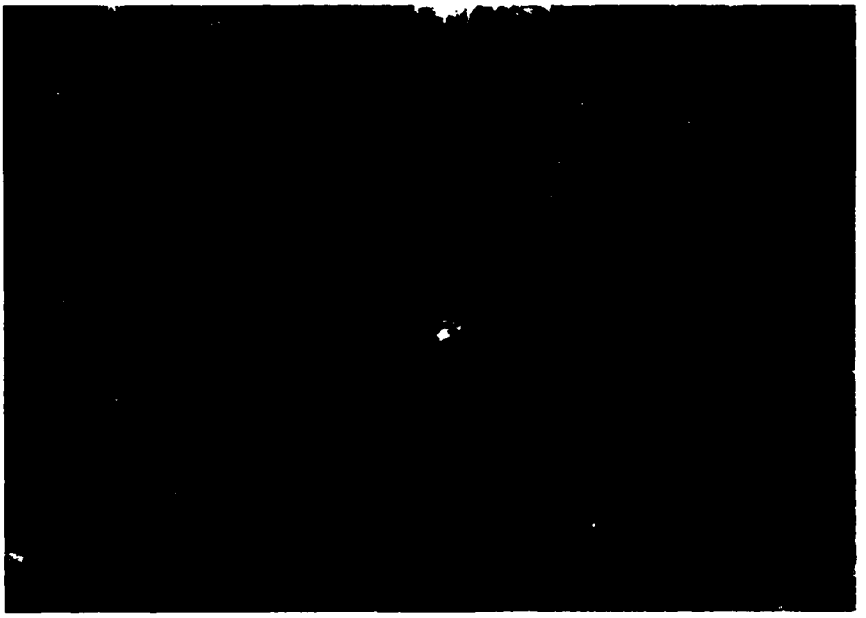


PHOTO 10: PRIMARY SPILLWAY PIPE AND DOWNSTREAM CHANNEL

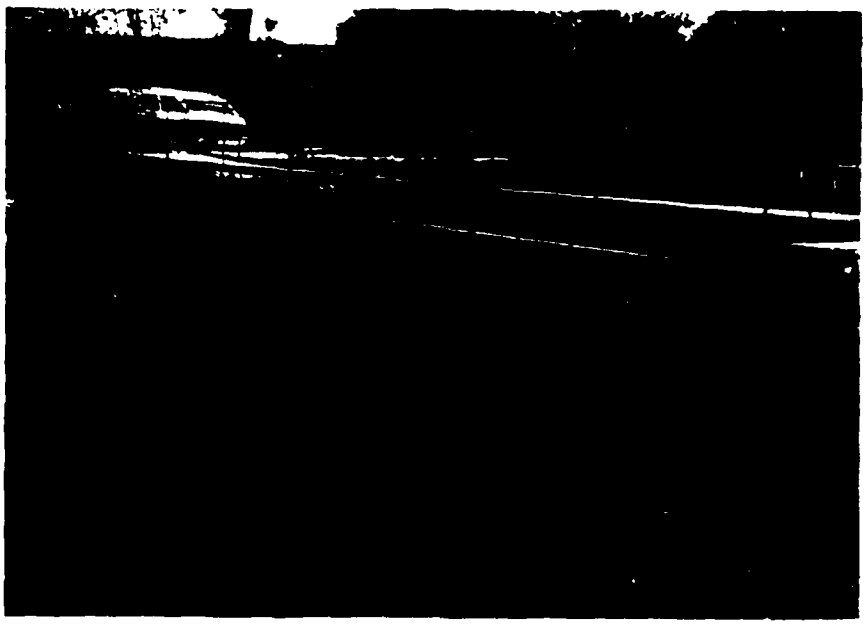


PHOTO 11: EMERGENCY SPILLWAY CHANNEL APPROACH

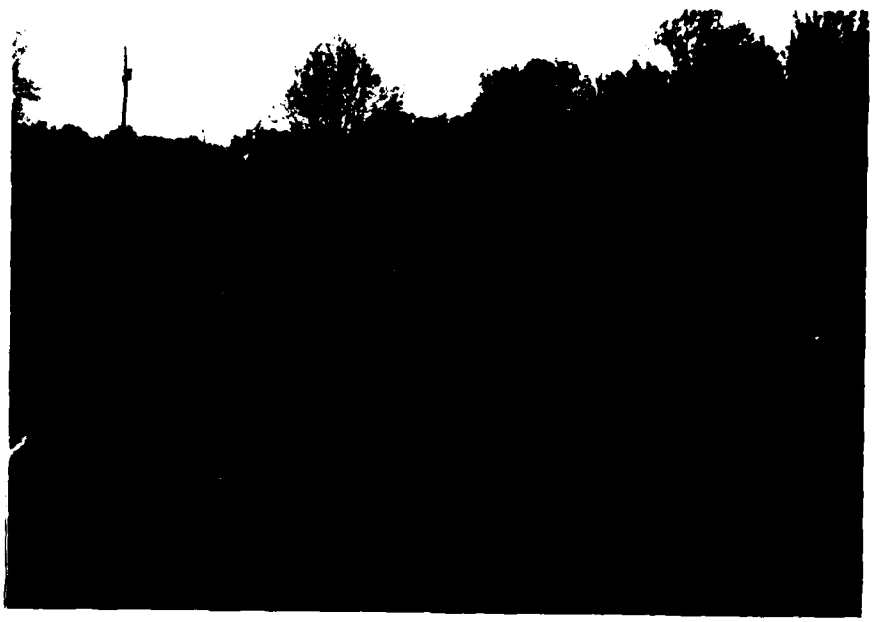


PHOTO 12: EMERGENCY SPILLWAY CHANNEL LOOKING DOWNSTREAM

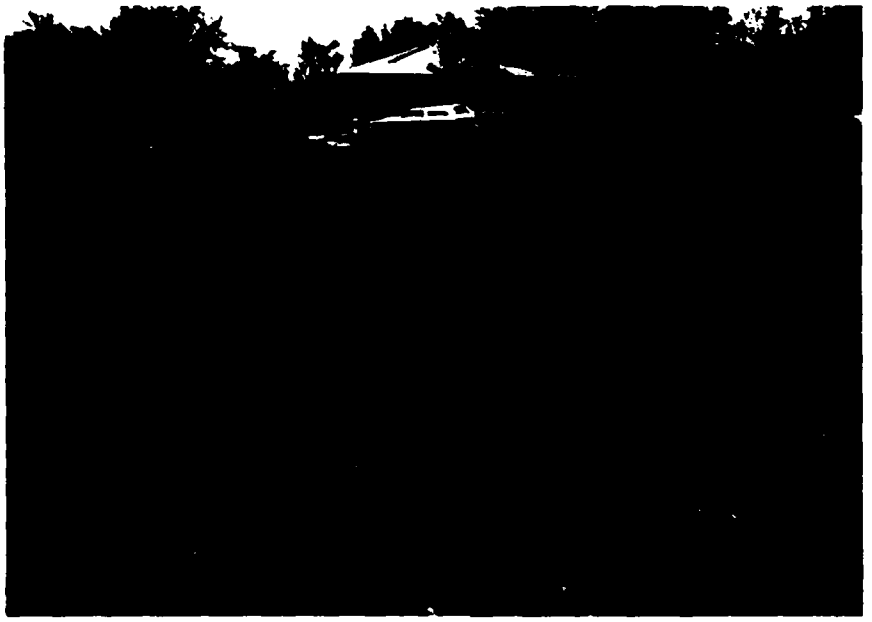


PHOTO 13: EMERGENCY SPILLWAY CHANNEL EROSION LOOKING UPSTREAM

PHOTO 14: EMERGENCY SPILLWAY CHANNEL OVERFALL SILL

PHOTO 15: EROSION ALONG FACE OF DAM AT WATERLINE

PHOTO 16: EROSION BELOW DAM NEAR PRIMARY SPILLWAY PIPE OUTLET

APPENDIX A

HYDROLOGIC COMPUTATIONS

HYDROLOGIC COMPUTATIONS

1. The Soil Conservation Service (SCS) dimensionless unit hydrograph and HEC-1 (L) were used to develop the inflow hydrographs and hydrologic inputs as follows:

a. Twenty-four hour, probable maximum precipitation determined from U.S. Weather Bureau Hydrometeorological Report No. 33.

200 square mile, 24 hour rainfall inches	- 24.75
10 square mile, 6 hour percent of 24 hour 200 square mile rainfall	- 101%
10 square mile, 12 hour percent of 24 hour 200 square mile rainfall	- 120%
10 square mile, 24 hour percent of 24 hour 200 square mile rainfall	- 130%

b. Drainage area = 756 acres.

c. Lag:

$$L = [\ell^{0.8} \times (S + 1)^{0.7}]/1900 \times Y^{0.5}$$

= 0.63 hours

= 38 minutes for the watershed for antecedent moisture condition III

where:

ℓ = 7,600 feet = hydraulic length of watershed in feet

$S = \frac{1,000}{CN} - 10$ where CN = 90 = hydrologic soil cover complex number

Y = 3.22% = average watershed land slope in percent

L = 0.95 hours = 57 minutes for the watershed for antecedent moisture condition II

where:

ℓ = 7,600 feet

$S = \frac{1,000}{CN} - 10$ where CN = 78

Y = 3.22%

d. The soil associations in this watershed are Blackoar, Higginsville, Leslie, Macksburg, Marshall, Polo, Sampsel, Snead, Sogn, and Winfield.

e. Losses were determined in accordance with SCS methods for determining runoff using a curve number of 90 for antecedent moisture condition III and a curve number of 78 for antecedent moisture condition

II. Approximately 50% of the drainage area was hydrologic soil group B; 38% of the drainage area was hydrologic soil group C; and 12% of the drainage area was hydrologic soil group D. The land uses in the watershed were projected to be 50% grassland and 50% cropland.

2. Primary spillway release rates were based on the minimum of the discharge calculated for flow into the drop inlet using the weir equation and the discharge calculated for flow through the pipe using the orifice equation.

Weir equation:

$$Q = C_o[2\pi R_s) H_o^{3/2}$$

where:

C_o ranges from 3.78 to 3.92 = weir coefficient for drop inlet spillways
R_s = 2.0 feet = radius of the drop inlet
H_o = head above the crest of the weir

Orifice equation:

$$Q = Ca[2gH]^{1/2}$$

where:

C = 0.42 = coefficient of discharge
a = 7.07 sq ft = net area of the orifice in square feet
g = gravitational acceleration
H = difference between the energy gradient elevation upstream and the tailwater elevation downstream

Discharge rates for the emergency spillway and over the top of the dam were determined by HEC-1 (1) given data describing the embankment crest. Discharge through the emergency spillway for the probable maximum flood and 50 percent of the probable maximum flood was determined by the unlevel weir equation:

$$Q = \frac{2Cb}{5(h_b - h_a)} (h_b^{2.5} - h_a^{2.5})$$

where:
C = 2.60 = weir coefficient
b = the length of flow normal to the weir in feet
h_b = the head on the low end of the weir in feet
h_a = the head on the high end of the weir in feet

3. The relationship between elevation and storage volume for the reservoir was determined from a contour map of the reservoir area. A planimeter measurement was made of the area enclosed by each contour line. The storage was computed by HEC-1 (1) given area and elevation data.

4. Floods were routed through the spillway using HEC-1, modified Puls to determine the capability of the spillway.

(1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July 1978, Davis, California.

(2) U.S. Department of the Interior, Bureau of Reclamation, Design of Small Dams, 1974, Washington, D.C.

(3) U.S. Department of Agriculture, Soil Conservation Service, Preliminary Soils Report for Lafayette County, Missouri.

(4) U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, August 1972.

(5) Horace W. King and Ernest F. Brater, Handbook of Hydraulics, Sixth Edition, McGraw Hill Book Company, 1976.

(6) U.S. Department of the Interior, Geological Survey, Techniques of Water-Resource Investigations, Book 3, Chapter A5, Measurement of Peak Discharge at Dams by Indirect Method, by Harry Hulsing, 1967.

(7) U.S. Department of Agriculture, Soil Conservation Service, Soil Interpretations and Field Maps, 1980.

(8) Mary H. McCracken, Missouri Division of Geological Survey, Geologic Map of Missouri, 1961.

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
    1                 AIMISSOURI DAM INSPECTION PROGRAM
    2                 A2ST. LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
    3                 A3ODESSA HILLS LAKE DAM
    4                 P     240         0         6         0         0         0         0         0         0         0
    5                 E1      5
    6                 J       1         9         1
    7                 J1     .1       .15        .2       .25        .3       .35        .4        .5       1.0
    8                 K       0         1                                     3         1
    9                 K1    ODESSA HILLS LAKE (24 HR. PROBABLE MAXIMUM RUNOFF)
   10                 M       1         2      1.18                           1
   11                 P                24.75      101       120       130
   12                 T                                                      -1       -90
   13                 W2               .63
   14                 X                          1
   15                 R       1         2                                    1
   16                 K1    ROUTING THROUGH ODESSA LAKE
   17                 Y                                    1         1
   18                 Y1      1                                            -765.0       -1
   19                 Y4  765.0     765.5     766.0     766.5     767.      767.5     768.5     769.5     770.5     771.5
   20                 Y4  772.5     773.5     774.5
   21                 Y5    0.0       17.       48.       87.      102.       104.      107.      109.      112.      114.
   22                 Y5  117.      119.      122.
   23                 SA  0.2       1.8       4.5      12.6      27.0      46.8
   24                 SE747.       750.      765.      770.      780.      790.
   25                 SS745.
   26                 SW769.4
   27                 SL0.        17.       32.       43.       91.      134.      202.      242.      286.      308.
   28                 SV766.0   766.1     766.7     769.4     769.8     770.4     770.5     770.8     772.0     773.
   29                 K      59
```

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	3	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	1.18	0.00	1.18	1.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.75	101.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
1	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-99.00	0.00	0.00

CURVE NO = -99.00 WETNESS = -1.00 EFFECT CN = 99.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .63

RECESSION DATA

STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH 35 END OF PERIOD ORDINATES. TC= 0.00 HOURS. LAG= .63 VOL= 1.00

54.	155.	319.	534.	720.	821.	836.	791.	705.	595.
456.	348.	272.	217.	172.	135.	104.	84.	65.	52.
41.	32.	25.	20.	16.	12.	10.	8.	7.	5.
4.	2.	1.							

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.06	1	.02	0.00	.02	0.	1.01	12.06	121	.25	.24	.01	585.
1.01	.12	2	.02	0.00	.02	0.	1.01	12.12	122	.25	.24	.01	611.
1.01	.18	3	.02	0.00	.02	0.	1.01	12.18	123	.25	.24	.01	664.
1.01	.24	4	.02	0.00	.02	0.	1.01	12.24	124	.25	.24	.01	754.
1.01	.30	5	.02	0.00	.02	0.	1.01	12.30	125	.25	.24	.01	875.
1.01	.36	6	.02	0.00	.02	0.	1.01	12.36	126	.25	.25	.00	1013.
1.01	.42	7	.02	0.00	.02	0.	1.01	12.42	127	.25	.25	.00	1154.
1.01	.48	8	.02	0.00	.02	0.	1.01	12.48	128	.25	.25	.00	1288.
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1.01	1.00	10	.02	0.00	.02	0.	1.01	13.00	130	.25	.25	.00	1509.
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1.01	1.12	12	.02	0.00	.02	0.	1.01	13.12	132	.30	.30	.00	1657.
1.01	1.18	13	.02	0.00	.02	0.	1.01	13.18	133	.30	.30	.00	1720.
1.01	1.24	14	.02	.00	.02	0.	1.01	13.24	134	.30	.30	.00	1785.
1.01	1.30	15	.02	.00	.02	0.	1.01	13.30	135	.30	.30	.00	1851.
1.01	1.36	16	.02	.00	.02	0.	1.01	13.36	136	.30	.30	.00	1916.
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1.01	2.06	21	.02	.00	.01	4.	1.01	14.06	141	.37	.37	.00	2153.
1.01	2.12	22	.02	.00	.01	6.	1.01	14.12	142	.37	.37	.00	2189.
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1.01	2.36	26	.02	.00	.01	16.	1.01	14.36	146	.37	.37	.00	2424.
1.01	2.42	27	.02	.00	.01	18.	1.01	14.42	147	.37	.37	.00	2494.
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1.01	3.18	33	.02	.01	.01	33.	1.01	15.18	153	.57	.57	.00	2783.
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1.01	3.30	35	.02	.01	.01	37.	1.01	15.30	155	1.71	1.70	.01	3035.
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1.01	4.30	45	.02	.01	.01	56.	1.01	16.30	165	.35	.35	.00	5987.
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1.01	4.48	48	.02	.01	.01	60.	1.01	16.48	168	.35	.35	.00	4291.
1.01	4.54	49	.02	.01	.01	61.	1.01	16.54	169	.35	.35	.00	3947.
1.01	5.00	50	.02	.01	.01	63.	1.01	17.00	170	.35	.35	.00	3676.
1.01	5.06	51	.02	.01	.01	64.	1.01	17.06	171	.27	.27	.00	3456.
1.01	5.12	52	.02	.01	.01	65.	1.01	17.12	172	.27	.27	.00	3275.
1.01	5.18	53	.02	.01	.01	67.	1.01	17.18	173	.27	.27	.00	3116.
1.01	5.24	54	.02	.01	.01	68.	1.01	17.24	174	.27	.27	.00	2969.
1.01	5.30	55	.02	.01	.01	69.	1.01	17.30	175	.27	.27	.00	2833.
1.01	5.36	56	.02	.01	.01	70.	1.01	17.36	176	.27	.27	.00	2706.
1.01	5.42	57	.02	.01	.01	71.	1.01	17.42	177	.27	.27	.00	2592.
1.01	5.48	58	.02	.01	.01	72.	1.01	17.48	178	.27	.27	.00	2493.
1.01	5.54	59	.02	.01	.01	73.	1.01	17.54	179	.27	.27	.00	2408.
1.01	6.00	60	.02	.01	.01	74.	1.01	18.00	180	.27	.27	.00	2339.
1.01	6.06	61	.04	.03	.03	77.	1.01	18.06	181	.02	.02	.00	2272.
1.01	6.12	62	.04	.03	.02	85.	1.01	18.12	182	.02	.02	.00	2192.
1.01	6.18	63	.06	.04	.02	99.	1.01	18.18	183	.02	.02	.00	2082.
1.01	6.24	64	.06	.04	.02	123.	1.01	18.24	184	.02	.02	.00	1923.
1.01	6.30	65	.08	.06	.02	155.	1.01	18.30	185	.02	.02	.00	1721.
1.01	6.36	66	.08	.06	.02	193.	1.01	18.36	186	.02	.02	.00	1498.
1.01	6.42	67	.08	.06	.02	233.	1.01	18.42	187	.02	.02	.00	1274.
1.01	6.48	68	.08	.06	.02	272.	1.01	18.48	188	.02	.02	.00	1064.
1.01	6.54	69	.07	.06	.01	308.	1.01	18.54	189	.02	.02	.00	878.
1.01	7.00	70	.06	.06	.01	340.	1.01	19.00	190	.02	.02	.00	724.
1.01	7.06	71	.08	.07	.01	367.	1.01	19.06	191	.02	.02	.00	607.
1.01	7.12	72	.08	.07	.01	390.	1.01	19.12	192	.02	.02	.00	517.
1.01	7.18	73	.08	.07	.01	409.	1.01	19.18	193	.02	.02	.00	448.
1.01	7.24	74	.08	.07	.01	426.	1.01	19.24	194	.02	.02	.00	392.
1.01	7.30	75	.08	.07	.01	440.	1.01	19.30	195	.02	.02	.00	348.
1.01	7.36	76	.08	.07	.01	453.	1.01	19.36	196	.02	.02	.00	313.
1.01	7.42	77	.08	.07	.01	464.	1.01	19.42	197	.02	.02	.00	286.

1.01	[illegible]	66	.08	.06	.02	193.	1.01	18.36	186	.02	.02	.00	[illegible]
1.01	[illegible]	67	.08	.06	.02	233.	1.01	18.42	187	.02	.02	.00	74.
1.01	6.48	68	.08	.06	.02	272.	1.01	18.48	188	.02	.02	.00	1064.
1.01	6.54	69	.08	.06	.01	306.	1.01	18.54	189	.02	.02	.00	878.
1.01	7.00	70	.08	.06	.01	340.	1.01	19.00	190	.02	.02	.00	724.
1.01	7.06	71	.08	.07	.01	367.	1.01	19.06	191	.02	.02	.00	607.
1.01	7.12	72	.08	.07	.01	390.	1.01	19.12	192	.02	.02	.00	517.
1.01	7.18	73	.08	.07	.01	409.	1.01	19.18	193	.02	.02	.00	448.
1.01	7.24	74	.08	.07	.01	426.	1.01	19.24	194	.02	.02	.00	392.
1.01	7.30	75	.08	.07	.01	440.	1.01	19.30	195	.02	.02	.00	348.
1.01	7.36	76	.08	.07	.01	453.	1.01	19.36	196	.02	.02	.00	313.
1.01	7.42	77	.08	.07	.01	464.	1.01	19.42	197	.02	.02	.00	286.
1.01	7.48	78	.08	.07	.01	474.	1.01	19.48	198	.02	.02	.00	264.
1.01	7.54	79	.08	.07	.01	483.	1.01	19.54	199	.02	.02	.00	247.
1.01	8.00	80	.08	.07	.01	490.	1.01	20.00	200	.02	.02	.00	234.
1.01	8.06	81	.08	.07	.01	497.	1.01	20.06	201	.02	.02	.00	224.
1.01	8.12	82	.08	.07	.01	504.	1.01	20.12	202	.02	.02	.00	216.
1.01	8.18	83	.08	.07	.01	509.	1.01	20.18	203	.02	.02	.00	209.
1.01	8.24	84	.08	.07	.01	514.	1.01	20.24	204	.02	.02	.00	204.
1.01	8.30	85	.08	.07	.01	519.	1.01	20.30	205	.02	.02	.00	200.
1.01	8.36	86	.08	.07	.01	523.	1.01	20.36	206	.02	.02	.00	197.
1.01	8.42	87	.08	.07	.01	527.	1.01	20.42	207	.02	.02	.00	195.
1.01	8.48	88	.08	.07	.01	530.	1.01	20.48	208	.02	.02	.00	193.
1.01	8.54	89	.08	.07	.01	534.	1.01	20.54	209	.02	.02	.00	191.
1.01	9.00	90	.08	.07	.01	537.	1.01	21.00	210	.02	.02	.00	190.
1.01	9.06	91	.08	.07	.01	539.	1.01	21.06	211	.02	.02	.00	189.
1.01	9.12	92	.08	.07	.01	542.	1.01	21.12	212	.02	.02	.00	188.
1.01	9.18	93	.08	.07	.00	544.	1.01	21.18	213	.02	.02	.00	188.
1.01	9.24	94	.08	.07	.00	546.	1.01	21.24	214	.02	.02	.00	188.
1.01	9.30	95	.08	.07	.00	548.	1.01	21.30	215	.02	.02	.00	188.
1.01	9.36	96	.08	.07	.00	550.	1.01	21.36	216	.02	.02	.00	188.
1.01	9.42	97	.08	.07	.00	552.	1.01	21.42	217	.02	.02	.00	188.
1.01	9.48	98	.08	.07	.00	554.	1.01	21.48	218	.02	.02	.00	188.
1.01	9.54	99	.08	.07	.00	555.	1.01	21.54	219	.02	.02	.00	188.
1.01	10.00	100	.08	.07	.00	557.	1.01	22.00	220	.02	.02	.00	188.
1.01	10.06	101	.08	.07	.00	558.	1.01	22.06	221	.02	.02	.00	188.
1.01	10.12	102	.08	.07	.00	560.	1.01	22.12	222	.02	.02	.00	188.
1.01	10.18	103	.08	.07	.00	561.	1.01	22.18	223	.02	.02	.00	188.
1.01	10.24	104	.08	.07	.00	562.	1.01	22.24	224	.02	.02	.00	188.
1.01	10.30	105	.08	.08	.00	563.	1.01	22.30	225	.02	.02	.00	188.
1.01	10.36	106	.08	.08	.00	564.	1.01	22.36	226	.02	.02	.00	188.
1.01	10.42	107	.08	.08	.00	565.	1.01	22.42	227	.02	.02	.00	188.
1.01	10.48	108	.08	.08	.00	566.	1.01	22.48	228	.02	.02	.00	188.
1.01	10.54	109	.08	.08	.00	567.	1.01	22.54	229	.02	.02	.00	188.
1.01	11.00	110	.08	.08	.00	568.	1.01	23.00	230	.02	.02	.00	188.
1.01	11.06	111	.08	.08	.00	569.	1.01	23.06	231	.02	.02	.00	188.
1.01	11.12	112	.08	.08	.00	570.	1.01	23.12	232	.02	.02	.00	188.
1.01	11.18	113	.08	.08	.00	571.	1.01	23.18	233	.02	.02	.00	188.
1.01	11.24	114	.08	.08	.00	571.	1.01	23.24	234	.02	.02	.00	188.
1.01	11.30	115	.08	.08	.00	572.	1.01	23.30	235	.02	.02	.00	188.
1.01	11.36	116	.08	.08	.00	573.	1.01	23.36	236	.02	.02	.00	188.
1.01	11.42	117	.08	.08	.00	574.	1.01	23.42	237	.02	.02	.00	188.
1.01	11.48	118	.08	.08	.00	574.	1.01	23.48	238	.02	.02	.00	188.
1.01	11.54	119	.08	.08	.00	575.	1.01	23.54	239	.02	.02	.00	188.
1.01	12.00	120	.08	.08	.00	575.	1.02	0.00	240	.02	.02	.00	188.
									SUM	32.17	30.88	1.30	233543.
										(817.)	(784.)	(33.)	(6613.20)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7358.	5062.	973.	973.	233461.
CMS	208.	87.	28.	28.	[illegible]

AC-FT	1518.	1929.	1929.	1929.
THOUS CU M	1873.	2380.	2380.	2380.

HYDROGRAPH ROUTING

ROUTING THROUGH ODESSA LAKE

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	1	0	0	0	0	1	0	0

ROUTING DATA

GLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPNP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-765.	-1

STAGE	765.00	765.50	766.00	766.50	767.00	767.50	768.50	769.50	770.50	771.50
	772.50	773.50	774.50							
FLOW	0.00	17.00	46.00	87.00	102.00	104.00	107.00	109.00	112.00	114.00
	117.00	119.00	122.00							
SURFACE AREA=	0.	2.	5.	13.	27.	47.				
CAPACITY=	0.	2.	48.	89.	282.	647.				
ELEVATION=	747.	75?.	765.	770.	780.	790.				

CELL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
765.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
769.4	0.0	0.0	0.

CREST LENGTH	0.	17.	32.	43.	91.	134.	202.	242.	286.	308.
AT OR BELOW ELEVATION	766.0	766.1	766.7	769.4	769.8	770.4	770.5	770.8	772.0	773.0

STATION 2, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

1.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	1.	1.
1.	1.	1.	1.	1.	1.	2.	2.	2.	2.
2.	2.	3.	3.	3.	3.	3.	3.	4.	4.
4.	4.	4.	4.	4.	5.	5.	5.	5.	5.
5.	5.	6.	6.	6.	7.	8.	9.	10.	11.
12.	14.	15.	17.	19.	21.	24.	26.	28.	30.
31.	33.	35.	36.	37.	39.	40.	41.	42.	43.
44.	45.	46.	46.	47.	48.	48.	49.	50.	50.
51.	51.	52.	52.	53.	53.	54.	54.	54.	55.
55.	56.	56.	56.	56.	56.	56.	56.	56.	57.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

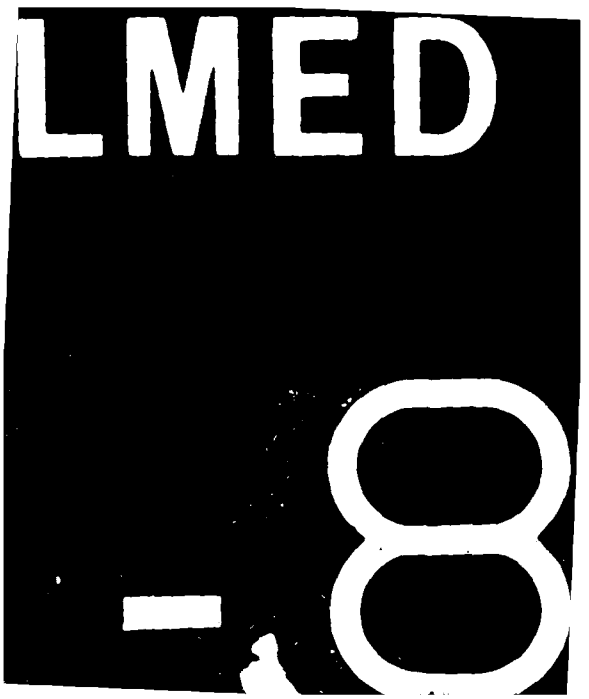
OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS								
				RATIO 1 .10	RATIO 2 .15	RATIO 3 .20	RATIO 4 .25	RATIO 5 .30	RATIO 6 .35	RATIO 7 .40	RATIO 8 .50	RATIO 9 1.00
HYDROGRAPH AT	1	1.17	1	734.	1101.	1468.	1835.	2202.	2568.	2935.	3669.	7338.
		3.03)		20.78)(	31.17)(	41.56)(	51.95)(	62.34)(	72.73)(	83.12)(	103.90)(	207.80)
ROUTED TO	2	1.17	1	595.	922.	1308.	1715.	2109.	2486.	2856.	3586.	7210.
		3.03)		16.85)(	26.19)(	37.03)(	48.43)(	59.71)(	70.40)(	80.86)(	101.55)(	204.17)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	765.00	765.00	769.45
STORAGE	48.	48.	81.
OUTFLOW	0.	0.	728.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	768.96	0.00	77.	595.	0.00	16.50	0.00
.15	769.93	.50	87.	922.	.90	16.50	0.00
.20	770.63	1.13	95.	1308.	1.60	16.40	0.00
.25	771.33	1.53	101.	1715.	2.20	16.40	0.00
.30	771.74	1.84	105.	2109.	3.30	16.30	0.00
.35	771.59	2.10	109.	2486.	4.10	16.30	0.00
.40	771.73	2.33	112.	2856.	4.80	16.30	0.00
.50	772.14	2.74	118.	3586.	5.50	16.30	0.00
1.00	773.71	4.31	144.	7210.	6.70	16.30	0.00


LMED
8